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I. *Extract of a Letter from Mr. Turbervill
Needham to Martin Folkes, Esq; Pr. R. S.
concerning some new Electrical Experiments
lately made at Paris.*

Paris, July 4. N. S. 1746.

S I R,

*Read at a Meeting
of the Royal Society,
Oct. 23. 1746.*

AS I have been myself, since my coming hither, greatly entertained with the curious electrical Experiments I have seen at Monsieur *le Monnier's*, I hope such an Account as I am able to give of them, will not prove disagreeable to you, notwithstanding you may very shortly expect a better from that Gentleman himself, who intends writing to you by the first Opportunity. Had I been versed in drawing, so that I could have delineated the *Apparatus* I have seen, I might both have shortened my Description, and have rendered myself more intelligible. As it is, you must excuse long Periods, take the Will for the Deed, and let the Singularity of the Facts themselves, make amends for the Manner of relating them: till Monsieur *le Monnier's* own Letter shall come, like the Sun after the Dawn, and give you full Satisfaction.

The electrifying Glass used by Monsieur *le Monnier* is an oblong Spheroid, whose Diameter from Pole to Pole is four or five Inches longer than that at the Equator, which is about twelve Inches. Each of these Poles is terminated in a Stem, or Portion of a hollow Cylinder, about three Inches in Length, and one in Diameter, spirally embossed on the Outside into a

large male Screw: To each of these male Screws is adapted a female Screw of Wood, closed at one Extremity with a Piece of Steel, excavated in the Center, to receive the steel Pivots upon which the electrifying Glass turns. These female Screws of Wood are so formed at their open Extremity, that they grasp and cover as much at the Poles, as nearly renders what appears of the glass Spheroid a perfect Sphere: this with a Design, that the Wood may fix the more effectually, and embrace the electrifying Glass. From the exterior Surface of one of these wooden female Screws, a circular Ledge rises, and projects to the Height of about two Inches; the *Ambitus* of which Ledge is excavated, to receive the Cord that turns the electrifying Glass. This is what they use here instead of our Tubes, and with surprising Effects, such as greatly surpass what you have yet seen in *England*. The electrifying Spheroid is turned by means of a Wheel about four Feet in Diameter, with the same Motion, and exactly in the same Manner, as the Spindle is turned round by the Spinning-Wheel: allowing a due Proportion to the Frame, upon which the glass Spheroid is mounted, that it may answer to the Wheel that turns it. The Sides of this Frame, which stand perpendicular to the Horizon, are near as strong and as large every Way, as the Posts of an ordinary Closet-Door; and, with the Ledges that join them at Top and Bottom, form a rectangular Parallelogram. The Front of this Frame is provided with silken Loops, conveniently disposed in several Places, to bring to, and fix at a Contact with the electrifying Glass, Wires, Threads, Packthread, or whatever else is to be electrified. Into one Side of this

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Frame,

Frame, at about half its Height, the Pivot that receives one of the Poles of the glass Spheroid is fixed; the other Pivot, on the opposite Side, is a round long Bar of Iron, screwed into and passing through the Post, in order to fix, or give Liberty of removing the electrifying Glass. This Bar of Iron, for the Convenience of turning it, has another in the Nature of a Leaver, which passes through its Extremity at right Angles with it. The whole Machine is mounted upon a Floor of Boards, Wheel, Frame, Glass, &c. and employs two Men, the one to turn the Wheel, the other to sit behind the glass Spheroid, and apply the Concave of each Hand to its lower convex Surface; for it is by this Friction that the Electricity is excited.

When the electrifying Glass has been some little time in Motion, the Person who desires to be electrified, applies the Extremities of the Nails of one Hand, and stands not upon Cakes of Wax, as in *England*, but within the Area of a square Drawer or Box about five Inches deep, and filled with five Parts Pitch, four of Resin, and one of Bees-wax: I will not call it a Composition, for they are not mixed, but disposed in the following Manner; the Pitch is placed next to the Sides of the Box, and rises almost to a Level with them, the Resin in the Middle is level with the Pitch, and the Wax forms a thin Surface, covering both to a Level with the Box it self; however, I suppose this to be in it self very indifferent, and that any one Body of the Electrics *per se* would answer equally.

EXPERIMENT I.

The Person electrified by this Machine not only emits Fire from all Parts of his Body, upon the Touch of another, with more Vigour, and in a much more sensible Manner, than when electrified by a common Tube; but fires also Spirits of Wine with such Ease, that when the Spirits have been once but simply set on Fire by a Match or Paper lighted, and the Flame has been instantly blown out, they will, with that small Degree of Heat they have acquired, take Fire upon his Touch ten or twenty times successively, without failing once.

I am told here, that they have frequently attempted in vain to fire Spirits with a common Tube of Glass; so that I believe the Use of the Tube has been more improved in *England* than in any other Place: But it is a downright Slavery, and in its Effects many Degrees inferior to this Machine. I should have thought, as this so much exceeds in Strength the common Tube, that many glass Spheroids, acting at once upon the same Body, would have considerably increased the Effect; but Monsieur *de Buffon* tells me, that Monsieur *le Monnier* had found, upon Trial, that they answered not his Expectations; so that it might seem there is a *Ne plus ultra* in the Intensity of Electricity, as well as in the Heat, which is communicated to boiling Water.

EXP. II.

If the Person electrified holds a Sword in one Hand, the Chamber being darkened, a continual Flame issues out at the Point, in Smell and Colour resembling the
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Fumes of *Phosphorus*, and near as strong as that of an Enameller's Lamp : with this Difference, that when any other of the Company applies a Hand, even to the very Point, where the concentrated Rays begin to diverge, it burns not, nor is any otherwise sensible to the Feeling, than as a continual Blast of Wind.

EXP. III.

This is performed with a square Bar of Iron, about four Feet in Length, and half an Inch in Thickness ; to one Extremity of which is adapted, by the Help of a Screw, another Piece of Iron beat flat, like the End of one of the Legs of a Pair of Tongs. This flat Piece of Iron being screwed in, the Bar is placed parallel to the Horizon upon a wooden Stand, and the Stand within the Area of the Drawer or Box, upon the Pitch, Resin, and Bees-wax, as above. The Extremity of the Bar, opposite to that, which carries the flat Piece of Iron, is covered with three or four Folds of Linen, to prevent any Damage that might happen to the glass Spheroid, in hitting against it by Accident, while it revolves round its Axis ; and the same Extremity is moreover, for further Security, placed at the Distance of about one Fourth of an Inch from the Glass itself, the Effect being the same in every respect, as if in Contact. The Operator then orders the Bar to be electrified by repeated Revolutions of the glass Spheroid, as above ; and places one Finger upon the Middle of the Bar, to prevent the Communication of the Electricity from one End to the other, till he has covered the flat Piece of Iron with as much Saw-dust as it will carry. Some other of the Company, in the mean while, takes up
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on the Point of a Knife likewise, a Quantity of Saw-dust, and holds it under the flat Piece of Iron, at about an Inch Distance. The Effect is, that when the Operator takes off his Finger, the Spheroid still continuing to revolve, the Saw-dust above is all repelled and blown off, and that under attracted upwards. If, instead of Saw-dust, you place upon the flat Piece of Iron a small square tin Box filled with Water, or any other Vessel made of a Matter non-electric *per se*, particularly metalline, and endeavour to draw off the Water by a capillary Siphon : the Water, in that Case, will fall Drop by Drop, as usually ; but the Instant the Bar is electrified, it will run in one continual Stream ; which, if the Chamber be darkened, will also appear luminous. This Play of the Water may again be stopped at Pleasure, by the Application of one Finger to the Bar, as above. If the flat Piece of Iron be unscrewed and removed, the Electricity runs out at the Extremity of the Bar, to the Eyes, in the Appearance of a blewish Flame ; to the Smell, like Fumes of *Phosphorus* ; and, to the Feeling, like a Blast of Wind ; as in the Experiment of the Sword.

EXP. IV.

The most surprising of all, is that of Mr. *Muschenbroeck*, improved by Monsieur *le Monnier*. A Musquet-Barrel open at both Ends, is suspended parallel to the Horizon, by silken Threads within Reach : and at the Breech End, about three Inches from the Extremity, is hung, by a Ring of Iron worked into the Barrel itself, a small iron Chain about half a Foot in Length. A glass Phial, resembling in Size and Shape

Shape a common Vinegar-Crewet, is then prepared, full of Water and well corked, with an iron Wire running through the Cork almost to the Bottom, and emerging some two or three Inches above it, out of the Top of the Phial. The Head of this Wire is bent, to catch in the lowest Link of the Chain; and is to be there suspended, when it has been electrified. From the Mouth of the Barrel, which is pointed in a Line parallel to the equatorial Plane of the revolving Spheroid, comes a long iron Wire, inserted into the Barrel itself, as far as one Third of its Length, and thence proceeding till it touches the glass Spheroid; to a Contact with which it is determined by one of the filken Loops I mentioned above in the Description of the *Apparatus*. Every thing being thus disposed, the Gun-Barrel is to be electrified by repeated Revolutions of the glass Spheroid; which is to be in a continual Contact with the long Wire that proceeds from it. The Phial is, at the same time, to be electrified by the Operator, who takes hold of the Body of the Bottle, and applies to the electrifying Spheroid the bent Extremity of that Wire, which passes from near the Bottom of the Phial through the Cork, as I described above. The Operator must take care not to touch the Wire itself, while he endeavours to electrify the Phial; otherwise he would be in the Case of one, who should aim to electrify himself, without standing upon some one of the Bodies, that are Electrics *per se*. When the Phial is sufficiently electrified, which will be done in eight or ten Revolutions of the Spheroid; for I would not have any one be too free in bestowing such an Efficacy upon it by too long an Application, as might perhaps,

perhaps, occasion his receiving a more violent Shock than he would be willing to feel, particularly if the glass Spheroid has been any time in Action, and is much heated thereby ; the Phial is then, I say, to be suspended by the iron Chain, the glass Spheroid continuing still to revolve about its Axis, and to electrify the Gun-Barrel : the Person then who has Courage enough to suffer the Experiment, for so I must express myself, grasps the Bottom of the electrified Phial with one Hand, and with the other touches the Gun-Barrel. At that Instant, a great Part of the nervous System receives a Shock so violent, that it would force the strongest Man to quit his Hold, and turn him half-round.

I remember, among others of us, that tried the Experiment, was a Boy of about fourteen : I asked him, what he thought of it ; he told me, that he imagined, the instant he touched the Gun-Barrel, his Arms had been broke short off at the Elbows, and that he had been cut into two Parts just below the Breast ; another of the Company, with a sort of Pun, termed it being broken upon the Wheel. In Effect, so far the Boy was in the right, that the Shock in the Arms seems to extend no farther than the Elbows, and that of the Body no lower than the Breast, without affecting however in the least the Head, or seeming to reach beyond the outward Expansion of the Nerves : yet is it not to be termed a Pain ; for there is not the least Sense of that sort in it, but a mere sudden convulsionary Motion, or rather a Shock, which surprises much, and is indeed an uneasy, though not a painful Sensation.

In this Experiment, it is very remarkable, how greatly the Force of the communicated Electricity is augmented, by the Application of the electrified Phial: But the most surprising Circumstance attending the Use thereof, and which, I believe, is, among all the Bodies that are susceptible of Electricity, peculiar to this alone, is, that it loses not entirely its Efficacy under several Minutes; and I am told, that in a Frost it will retain it for six-and-thirty Hours together.

Monsieur *de Buffon*, who informed me that Monsieur *le Monnier* was the first who discovered this Particular, has also assured me, that this same Gentleman had frequently electrified the Phial at home, and brought it in his Hand through many Streets from the College of *Harcourt*, to his Apartments in the King's Garden, without any very sensible Diminution of its Efficacy. The Use of the electrified Phial may be diversified many Ways: among others are such as follow.

EXP. V.

When the Phial has been sufficiently electrified as above, the whole Company join Hands; the Operator at one Extremity of the Line grasps the Bottom of the electrified Phial, and the Person at the other Extremity touches the Wire, which rises above the Cork. At that Instant, the whole Company receives a Shock, resembling that in the Experiment of the

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Gun-Barrel, but not so strong; for it seems not at all to extend beyond the Elbows.

This is the Experiment, which Abbè *Nollet* performed upon 180 of the Guards, before the King, who were all so sensible of it at the same Instant of Time, that the Surprise caused them all to spring up at once; as it will indeed force any Person to do that subjects himself to the Trial; tho' the convulsionary Motion itself, as I observed before, reaches not beyond the Elbows: But the greater or lesser Effect depends entirely upon the longer or shorter Application of the Phial to the electrifying Spheroid; and I am credibly informed, that when due Precautions have not been taken in this Particular, some Persons have received such violent Shocks, as have benumbed, and impaired, to a certain Degree, the Use of their Arms for a Day or two, before they perfectly recovered themselves. I can assure you, however, from my own Experience, that, with the Precautions I have already taken notice of, there is no manner of Danger, tho' at the same time a sufficient Efficacy may be communicated to the Phial, to gratify any one's Curiosity: And in this Particular I have been the more prolix, lest any bad Consequence should happen to the unexperienced.

EXP. VI.

Another Experiment with the electrified Phial consists, first, in placing a Wire fixed in a Pedestal, erect in a Bason of Water, the Head of which Wire is bent, and rises some three or four Inches above the Level
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of the Water; and then, in touching the Surface of the Water with one Hand, and the standing Wire with the Wire of the electrified Phial, which is grasped by the other Hand, as in the preceding Experiments. The Effect of this is much more violent than that of the last Experiment, and I think, exceeds even the Shock of the Gun-Barrel; so that here the utmost Precaution must be used, not to electrify the Phial too much.

I observed particularly upon the Trial of this, that the Operator, who appeared to be very expert, and quite familiarized with every former Effect, shewed however some Apprehension, and was unwilling to lead the Way, as he had done in all the other Experiments.

EXP. VII.

If the electrified Phial is held in the Hand, and the Chamber is darkened, the Wire inserted in it is perceived to emit a Stream of Fire at its Extremity without any Discontinuance; but if it is suspended by a silken Thread, the fiery Eruption instantly ceases.

This, as a Person would be apt to imagine, gives some Insight into the Reason of its Retention of Electricity; the ambient Glass and silken Thread being in the Number of the Electrics *per se*, which have a Power of determining to, and confining in, any other kind of Body, a communicated Electricity, though they are not susceptible of it themselves. Yet, as the *French* observe very well, there are so many of what they term *Bi-*

zarreries, or unaccountable *Phænomena*, in the Course of electrical Experiments, that a Man can scarce assert any thing, in consequence of any Experiment, which is not contradicted by some unexpected Occurrence in another: At least, this is my present Thought of the Matter; and I am the more confident in advancing it, since that I have learnt your Friend Monsieur *de Buffon* is of the same Opinion, for whose Judgment I have the greatest Deference. I remember he told me one Day, when I had the Honour of waiting upon him, that he thought the whole Subject of Electricity, though illustrated with so great a Variety of Experiments, very far from being yet sufficiently ripe for the Establishment of a Course of Laws, or indeed of any certain one, fixed and determined in all its Circumstances. An Instance of this, among others that are or may be found out, will appear in the following Experiment.

EXP. VIII.

If the non-electrified Phial is placed upon a glass Salver, it acquires from the Revolution of the Spheroid no Electricity, though its Wire is in Contact with it all the Time; unless the Finger of some one in the Company is approached very near to the Phial itself: But, in that Case, it receives it visibly from the Finger; insomuch that, if the Chamber is darkened, you will see the electrical Fire streaming out of the Finger, and entering into the Water,
through

through the Body of the glass Phial, which is thereby immediately impregnated with it; and this, though the Hand should be placed even under the glass Salver itself.

Here we see an Example, where an Electric *per se* is so far from terminating or excluding the Power of Electricity, that it is even made a *Medium* of Communication in Circumstances where the Wire, which is a Non electric *per se*, refuses to perform its expected Office. When I speak of the Power of Electricity in this Case, I would not be understood of the Power of attracting light Bodies, which is well known to be scarce sensibly interrupted by a glass *Medium*, as appears in the common Experiment of an electrified Tube, acting upon Leaf-Gold, in a crystal Bottle: Though even this, if duly considered, might create some Difficulty; but I would only be understood of that communicated Virtue, which renders Non-electrics *per se* electrical. In one Word, the Singularity of this Experiment is, that, by the Addition of the glass Salver, the Wire and the Water, both of them Non-electrics *per se*, should not be in the least affected without the Approach of a Hand, and should then receive the electrical Fire from it through a glass *Medium*; notwithstanding they are in the very same Circumstances, that a Man is in, or any other Non electric *per se*, placed upon a Cake of Wax and in Contact with the electrifying Spheroid. Now, that in this Experiment the glass Salver has a considerable Effect, is very clear. For,
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if the Phial is placed upon the Table, or upon a Stand, without the Salver, a few Revolutions of the Spheroid will with Ease communicate a strong Electricity to it; particularly if any one touches the Table or Stand it is placed upon: and to know whether any Degree of Electricity has been communicated or not, the Phial is to be brought to the Test of any of the preceding Experiments.

EXP. IX.

If the electrified Phial is placed upon a Table, and any light Body is suspended by a silver Thread, within the Distance of about two Inches from the Phial, what I saw was a small brass Bell of a Lap-dog's Collar, the Phial will attract that light Body to it with Force, if any of the Company touch the Wire of the Phial; but if the Phial-itself is touched, it will repel it with a Force equal to its Attraction in the former Case.

EXP. X.

This Experiment consists in the Communication of the electrical Fire from the glass Spheroid to many Persons at once, as in *England* from a Tube; with this only Difference, that the Company do not here join Hands, but are united to each other by taking hold of iron Chains, which surprisingly increase the Force of the communicated

communicated Electricity : For it is to be observed, that, whenever the Communication is carried on by a metallic *Medium*, the Effects are much the more sensible.

EXP. XI.

This Experiment is no other than what has been frequently tried in *England*, the Attraction of Leaf-gold by a hollow wooden Globe, to which Electricity is communicated, by a Packthread of a very great Length suspending it; after it has been conducted over silken Threads crossing the Chamber at several Distances, in a sort of Spiral, consisting of as many Turns as the Place will admit.

I had almost forgot to take notice of two Particulars, which were the Consequences of some of the preceding Experiments, and may in some measure serve to illustrate them: The one regards the Communication of Electricity; the other, its surprising Force.

At the grand Convent of the *Carthusians* here in *Paris*, the whole Community formed a Line of nine hundred Toises, by means of iron Wires of a proportionable Length, between every two; and, consequently, far exceeding the Line of the 180 of the Guards above-mentioned. The Effect was, that, when the two Extremities of this long Line met in Contact with the electrified Phial, the whole Company, at the same Instant of Time, gave a sudden Spring, and all equally felt the Shock, that was the Consequence of the Experiment.

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The other *Phænomenon* was the Result of a late Experiment of Abbè *Nollet's*. He fixed, at the two Extremities of a brass Ruler, two small Birds, a Sparrow and a Chaffinch: This Ruler had a Handle or Pedestal fastened to the Middle of it, for the Convenience of holding it. When both the Gun Barrel and the Phial had been sufficiently electrified, as in the 4th Experiment, he applied the Head of the Sparrow to the suspended Phial, and the Head of the Chaffinch to the Barrel. The Consequence, upon the first Trial, was, that they were both instantaneously struck lifeless, as it were, and motionless, for a Time only, and they recovered some few Minutes after: but, upon a second Trial, the Sparrow was struck dead, and upon Examination found livid without, as if killed with a Flash of Lightning, most of the Blood-vessels within the Body being burst by the Shock. The Chaffinch revived, as before.

This is, Sir, the exactest Relation I have been able to put together, of a Series of Experiments I have been exceedingly surpris'd with: And which I should sooner have transmitted to you, had I not been obliged to employ some time in the clearing up several Particulars, and in the satisfying myself about some of the Facts, by repeated Trials, before I would venture to give you an Account of them.

That

That you may very long enjoy the most perfect
Health and Happiness, is the sincere Wish of,

S I R,

Your most obliged

Humble Servant,

Turbervill Needham.

II. *Via Cometæ*